Appendix I

Bioregional Ecosystem Drivers

Appendix I is an excerpt prepared by DFG and is a summary of the principle bioregional ecosystem drivers operating within each bioregion as described in the California Wildlife Action Plan (no date).

Appendix I

Summary of principle bioregional ecosystem drivers relevant to the Vegetation Treatment Program and identified in the California Wildlife Action Plan (DFG, no date)

Mojave

Growth and Development

Existing local government General Plans provide for residential growth in the western Mojave to reach a population of 5 million (BLM, 2005b, Hunter et al., 2003). Significant growth is not anticipated in the eastern Mojave of California, where there is little infrastructure (BLM, 2002b). In the western Mojave, sprawling development replaces and fragments desert habitat. Growing communities require additional rights-of-way for power lines, pipelines, and roads, further fragmenting habitat.

Invasive Plants

Numerous exotic non-native plants have altered plant communities across large areas of the Mojave Desert, outcompeting native species and degrading upland and riparian habitats for native wildlife. The abundance of exotic forbs and annual grasses (particularly *Schismus barbaratis, Sarabicus, and Bromus madritenus rubens*) increases the fuel and continuity of fuels, facilitating more-frequent and hotter firesThis destroys the less-fire-intolerant native plants and facilitates other exotic plants that thrive in disturbed areas, further transforming the plant communities (Brooks and Matchett, 2002; Brooks and Pyke, 2001; D'Antonio, 2000)

Colorado Desert

Growth and Development

As a whole, the Colorado Desert region does not face the level of population and development pressure experienced across most of California, and it remains the state's second-least populous region (CERES, 2004). However, some areas of the Colorado Desert have seen significant growth in recent decades and are facing the resulting challenges to regional wildlife. The two most notable examples are the Coachella Valley and southern Imperial County near the U.S.–Mexico border cities of Calexico and Mexicali. Coachella Valley is home to a series of fast-growing communities stretching from Palm Springs eastward to Indio and including outlying communities of Mecca, Coachella, Thermal, and North Shore in the southeast (BLM, 2002a). Expanding communities also increase the need for infrastructure, including roads, powerlines, and water supply. As in other areas of the state, threats to wildlife include direct destruction of habitat, pollution, fragmentation of habitats, blockage of migratory corridors, and introduction of non-native and potentially invasive species.

Invasive Plants

In the Colorado Desert region, non-native saltcedar, or tamarisk, presents the greatest challenge. Tamarisk is virtually ubiquitous in riparian areas along the Colorado River. Alteration of the river's natural flow regime favors invasive tamarisk over native vegetation, in part because some native species are adapted to the historical seasonal flooding regime for dispersal and germination.

South Coast

Growth and Development

Intensive population and development pressures have resulted in a greater number of threatened and endangered species in the South Coast region than any other location in the continental U.S. (USGS, 2003). Nearly half of California's residents live in a region that encompasses less than a tenth of the state's land area (FRAP, 1997). Along the coast, development spread across the relatively flat coastal plains and mesas. Between 1940 and 2000, Los Angeles County grew from 2.79 million residents to 9.52 million, San Diego County from 289,000 to 2.81 million, and Orange County from 131,000 to 2.85 million (CDOF, 2004, SCAG, 2004). Large portions of the region's natural areas have been converted to other uses; currently, nearly 40 percent the South Coast's land area is in urban and suburban use (California Legacy Project / UC Davis Information Center for the Environment, 2004, CDF, 2002). With the expansion of the urban-wildland interface, remaining natural lands become more vulnerable to the incursion of invasive plants and animals, air and water pollution, and altered fire regimes. Developed areas, roads, and utility corridors fragment landscapes and sever connections between habitat areas.

Invasive Species

As in other regions across the state, invasive species problems on the South Coast are tied to regional land use and management issues. In terrestrial ecosystems, a number of highly aggressive non-native plant species invade grasslands and scrub, including yellow starthistle, artichoke thistle, medusahead, Pampas grass, fennel, pepper weed, black mustard, and castor bean. These species lower habitat quality for sensitive wildlife species such as the Quino checkerspot butterfly and the California gnatcatcher. Some of these species dry out earlier in the summer than native species and contribute to increased wildfire frequencies. Nest parasitism by brown-headed cowbirds also threatens many of the region's sensitive bird species, including least Bell's vireo, southwestern willow flycatcher, and California gnatcatcher.

Altered Fire Regimes

Wildfire is a natural and important ecological process in the South Coast. Widespread forest management practices, as well as increases in human-caused wildfires, have altered fire regimes, in some cases causing dramatic changes in regional habitats. Efforts to establish fire regimes that approximate historical fire patterns and frequencies while also minimizing loss of property and life are important to maintain and restore wildlife habitat. The causes and ecological consequences of wildfires differ among the region's ecological communities. In sage scrub, chaparral, and grassland systems, lightning-induced fires are fairly infrequent. Human-caused fires, however, have resulted in unnaturally high fire frequencies, especially along roads and near the urban-wildland interface, with some locations experiencing three fires within a period of 15 to 20 years (Spencer 2004 pers. comm.). Increased fire frequencies favor the Mediterranean grasses that were introduced to the region with the arrival of European settlers and livestock. Once established, the non-native grasses grow in a dense-thatch pattern that chokes out native vegetation and lowers habitat quality for wildlife. The dense grass also provides ample fuel for the cycle of frequent burning (Keeley, 2004)

Central Coast

Growth and Development

Population growth in the Central Coast has mirrored the rapid pace of growth seen statewide, with the region's population growing by approximately 13 percent to approximately 1.5 million between 1990 and 2000 (CDOF June 2004, DWR 2004). Throughout the region, urban acreage increased by 32 percent (from 182,000 acres to 241,000 acres) between 1980 and 1990 (DWR 1993) and by another 22 percent (to 293,000 acres) by 2002 (CDF 2002). Historically,

population pressures have been greatest along the coast, with inland areas primarily occupied by large ranches, agriculture, and small agricultural towns.

Livestock Grazing

Livestock grazing is widespread throughout the Central Coast region, especially on expansive ranch lands across the inland hills and mountain ranges (Newman et al., 2003, Thorne et al., 2002). Private grazing lands are estimated to total approximately 4.8 million acres, or 60 percent of the region's land area (FRAP 2003). Many public and conservation lands are also open to grazing, and Fish and Game, State Parks, and private land trusts make use of grazing as a habitat management tool. Grazing leases are also held on approximately 46 percent of the 1.7 million acres (Stephenson and Calcarone 1999) of the Los Padres National Forest lands within the region and on about 66 percent of the 300,000 acres of BLM land (FRAP 2003). Grazing's effects depend largely on rangeland management practices, including when and how long grazing occurs and the type and number of livestock. Well-managed livestock grazing can benefit sensitive plant and animal species, particularly in areas where annual grasses and invasive plants are established.

Invasive Species

As in other regions of California, invasive species present a noteworthy threat to the Central Coast's biological diversity and are tied to regional land uses. A number of the region's highly invasive exotic plant species are associated with inappropriately grazed rangelands and pastures, including starthistle, medusahead, and black mustard. Other invasive plant species in the region, including Pampas grass and cape ivy, either are or have been sold as ornamental plants and have escaped from cultivation. Numerous invasive plant species are established in the region's beaches, dunes, sandy coastal soils, and lowland areas. Outcompeting and displacing native plant communities, these invasive species often provide inferior habitat for wildlife. Veldt grass, associated with sandy soils, can shift native shrub communities toward grasslands and is of particular concern in San Luis Obispo and Santa Barbara counties, notably at Vandenberg Air Force Base, Guadalupe Nipomo Dunes, and around Morro Bay (Bossard et al., 2000). Aquatic systems also face a number of threats from invasive plant species. In watersheds subject to high levels of agricultural land use, such as the Salinas, Pajaro, and Santa Ynez drainages, giant reed and tamarisk species replace native riparian vegetation and provide lower-quality habitat for sensitive species like least Bell's vireo, California red-legged frog, Western pond turtle, and kit fox. Because giant reed and tamarisk provide limited shade, proliferation of these species also results in higher water temperatures and lower levels of dissolved oxygen (Bossard et al., 2000).

North Coast

Forest Management

Forestry is the most widespread land use in the North Coast–Klamath Region, which is one of the state's leading timber-producing regions (FRAP 2003). There are 1.9 million acres of privately owned timber production lands in the region, the majority located in the coastal portion of the region and owned by large private timber companies (USFWS September 2005). Inland, a large proportion of the region's forest lands are in public ownership. The region's five national forests (Six Rivers, Klamath, Shasta-Trinity, Mendocino, and a small portion of the Siskiyou) comprise 4.8 million acres (34 percent of the region) and are managed by the Forest Service and the Bureau of Land Management. Historical forest management practices resulted in significant effects on the region's forest habitats and waterways. Regulations governing current logging

practices and advances in technology have substantially improved timber-harvest practices. However, some ongoing management practices continue to adversely affect the vegetation communities and wildlife habitats of forest systems. Fire suppression and lack of harvest or thinning in areas planted for timber production result in unnaturally dense growth. This dense, woody growth can displace open-forest habitats like meadows and prevent sunlight from reaching the forest floor to support herbaceous vegetation. Natural and human-caused disturbances (including timber harvest) also can benefit forest communities by creating canopy gaps that allow for the growth of understory vegetation and edge-habitats that are important to some of the region's wildlife species. Timber harvest can fragment forest lands, sometimes with adverse effects on wildlife and ecosystems. Under standards established by the National Clean Water Act, many regional rivers (including the Big, Gualala, Russian, Navarro, Mattole, Eel, Mad, Scott, and Trinity rivers and Redwood Creek) are considered impaired due to excessive sediment loads and elevated temperatures that are at least partially attributable to timber harvest (SWRCB 2002a).

Altered Fire Regimes

Wildfire is an ecologically important natural disturbance in the North Coast–Klamath Region. Over the last century, forest management and land development activities have altered the role of fire in the region. Fire suppression has had important effects on the region's forest ecosystems. Because fires have not been allowed to burn, many areas of today's forests are denser than early 20th-century forests, and many meadow habitats have been filled in by forest growth. In other places, however, human activities have contributed to an increased frequency or severity of fires. Roads and rural residential development that expand the wildland urban interface can lead to an increased incidence of human-caused fire. Additionally, some tree plantations experience more frequent severe fires than multi-aged forests (Odion et al., 2004). Climate is also a major factor in determining fire patterns. Climate scientists project warmer and drier conditions in the coming century (Hayhoe et al., 2004, Schneider et al., 2002). These changes will add another variable to efforts to develop management measures that can approximate the historical role of fire in maintaining the mosaic of habitats and multi-aged forests naturally found across this landscape.

Growth and Development

When compared to other areas of California, the North Coast–Klamath Region is sparsely populated. Rugged topography has limited urban and agricultural development across much of the region. Currently, urban land use occurs on about 2 percent of the region's area, and low-density rural residential development is found on less than 2 percent (DWR 2004, FRAP 2003). Agriculture occupies about 7 percent (CDC 2002). However, in flatter coastal areas and valleys, urban and agricultural land uses are widespread and have substantially reduced and altered wildlife habitats. The region's population centers include coastal cities (Eureka, Arcata, Fort Bragg, and Crescent City) and, inland, Santa Rosa and Redding. In the interior portions of the region, residential growth has closely followed agricultural development in the major valleys. Some areas, like Humboldt and Siskiyou counties, are seeing increasing subdivision of large landholdings into smaller parcels for second-home and rural residential development. The most significant population pressures are felt in the southern portion of the region and in the Russian River basin, with population growth in Napa and Sonoma counties beginning to expand to Mendocino and Lake counties. Agricultural development has occurred primarily in the major river valleys, where common crops are alfalfa and irrigated pasturelands. Agricultural uses also

occur on coastal grasslands, where dairy operations are widespread, and on alluvial plains formed at the coastal outlets of large rivers. Some southern portions of the region support wine grapes, nursery stock, and orchards. Vineyard acreage, in particular, is expanding from Napa and Sonoma counties to Mendocino and Lake Counties

Livestock Grazing

Livestock grazing on private lands is prevalent in many portions of the region. Livestock also graze on public lands; approximately 39 percent of the 4.8 million acres of national forest lands (USFS 2005b) within the region and about 10 percent of the 646,000 acres of BLM land are leased for grazing (BLM 2005a). The effects of grazing depend largely on rangeland management practices, including the seasonality and duration of grazing and the type and number of livestock. Livestock grazing in riparian areas can be a cause for concern because cattle will congregate in these habitats, using them as water sources. Livestock trampling of stream channels results in collapse of stream banks and erosion of soils. In the coastal portion of the region, more than 40 percent of the river miles listed as impaired under the Federal Clean Water Act list grazing as one of the causes of pollution (FRAP 2003).

Invasive Species

Dune habitats are naturally dynamic, with dune migration serving as a natural disturbance that keeps early successional dune and beach habitat available. Because coastal development and urbanization have occurred along many of the region's sandy beach areas, dunes are limited in their ability to migrate. This problem is exacerbated by colonization by non-native plants, including European beach grass and yellow bush lupine, which form dense monocultures of vegetation and result in unnatural stabilization of beach and dune systems (Bossard et al., 2000). These invasive plants also displace native vegetation, including short-grass areas, degrading the habitat of such sensitive species as western lily and hippolyta fritillary. In salt marshes and coastal estuaries, particularly around Humboldt Bay, native plant communities are threatened by introduced dense-flowered cordgrass. Inland areas of the region are being invaded by such noxious weeds as yellow starthistle, spotted knapweed, and Scotch broom (Bossard et al., 2000). Most of these invasive exotic plants spread via roadways and river corridors and then invade surrounding lands as a consequence of disturbance by fire, forest management practices, or agricultural practices and livestock grazing.

Modoc

Livestock Grazing

Livestock production is a major economic activity of northeastern California. Livestock in the region are typically grazed on private lands in the winter and moved to BLM and Forest Service lands in the spring and summer (Roush 2005 pers. comm.). As upland grasses and forbs dry in the summer, livestock grazing intensifies around riparian and meadow habitats and browsing shifts to other higher-protein sources such as bitterbrush, mountain mahogany, and aspen; annual bitterbrush leaders and willow and aspen shoots are consumed (Loft et al1998, Menke et al., 1996, USFS 1991b, Young and Clements 2002b). Exotic annual grasses, particularly cheatgrass, carpet the landscape with fine fuels conducive to more frequent fires in shrub-grass plant communities (Pellent 1996 and 2002). Intentional clearing of sagebrush stands to improve range conditions for livestock also contributed to the transformation of shrub habitats. This combination of grazing-associated stressors has caused landscape-level changes, resulting in steep declines in the sagebrush, bitterbrush, and mountain mahogany plant communities.

Reduced fire frequency and livestock grazing throughout the growing season have contributed to the decline of aspen communities in the region. Livestock, in addition to deer and elk, consume aspen suckers and shoots and compact soft soils, preventing the successful regeneration of aspen stands (Burton 2002, Loft et al., 1987).

Altered Fire Regimes

Specific plant communities or habitats have evolved within ranges of fire-return intervals. At higher elevations, natural wildlife habitats of northeastern California are adapted to specific fire-return intervals of between 12 and 30 years. At lower elevations and drier sites dominated by shrubs, with less dense fuel, natural fire return intervals may be 30 to 100 years (Brooks and Pyke 2001, Chang 1996, Young et al., 1988). However, for the past 150 years, land-use activities, native and non-native plant invasions, and fire suppression have increased or decreased fire frequencies, upsetting fire regimes and degrading habitat for native species (Arno and Fiedler 2005). The proliferation of flammable annual grasses led to increased fire frequency in many areas, reducing less fire-tolerant shrubs, such as big sagebrush, mountain mahogany and lower-elevation bitterbrush. More-frequent fire disturbance has facilitated additional invasions of non-native plants, further transforming the plant community, which is now dominated by invasive grasses less suitable for native wildlife (Brooks and Pyke 2001, McAdoo et al., 2002). Reduced fire frequency allowed western juniper to expand its coverage into sagebrush, bitterbrush, mountain mahogany, riparian, and aspen plant communities (BLM 2000, Miller and Rose 1999). Juniper has flourished by outcompeting other vegetation for water and nutrients and altering ecosystems to such an extent that other once-abundant native plants and wildlife are now scarce in these areas. In the last 130 years, juniper has increased its coverage in the plant communities tenfold and now covers over 2.5 million acres of northeastern California (EOARC 2004, USFS July 2004).

Invasive Plants

Numerous exotic grasses and plants, like perennial pepper weed, annual medusahead, red brome, and various non-native thistles, have displaced native plants and altered local plant communities. One species, cheatgrass, has had a particularly dramatic impact on native shrub and grassland communities. Once established and abundant, cheatgrass facilitates frequent fires by providing a carpet of fine fuels, which carry fire more efficiently than well-spaced native perennial grasses and native shrubs (Pellant 1996). Plant species slow to recolonize following fire, like bitterbrush and sagebrush, decline with increased fire frequencies.

Aquatic Ecosystems

Many of the stressors affecting terrestrial habitats also combine to impact the aquatic ecosystems and species of northeastern California. Unique fish communities, native trout, amphibians, and invertebrates are at risk in aquatic systems throughout the region. Unique fish and invertebrates have evolved in isolated springs and segments of the Pit River watershed. Fourteen native fish species are found in various associated fish communities in segments of the watershed's rivers and creeks. Endemic aquatic species inhabit the watershed, including the Modoc sucker, the Goose Lake redband trout, Goose Lake tui chub, Goose Lake lamprey, Cow Head Lake tui chub, and the Shasta crayfish (Ellis and Cook 2001, Moyle 2002). Creeks of the northern Modoc Plateau (or Lost River watershed) drain to Clear Lake. The outlet of Clear Lake is the Lost River, which circles north into Oregon farmland and then joins the Klamath River system. The Lost River watershed has its own endemic aquatic fish and invertebrates. In these watersheds, the effects of timber management practices (particularly erosion from logging roads), livestock

grazing, and nutrient runoff from farms have degraded creeks and rivers, negatively affecting ecosystems that support aquatic and riparian species. The State Water Resources Control Board lists the Pit River and Fall River as impaired—failing to meet state water quality standards. One hundred twenty-three miles of the Pit River fail to meet state water quality standards. Grazing and farm waste runoff have increased water temperature and polluted the river with excessive nutrients, lowering dissolved oxygen. Many Pit River tributaries suffer similar degradation from land-use practices (SWRCB 2002b).

Forest Management

The cumulative effects of evenaged timber-harvest practices, elimination of older trees, snags and brush, logging-road construction, and fire suppression have changed forest plant communities. While some of these stressors have been reduced in recent years, they all continue to affect the forests' ecosystems and wildlife. Fire-tolerant old forests, often with open canopies, have been replaced by dense evenaged forests that lack diverse wildlife habitat features and are prone to devastating wildfires. Maintaining diverse wildlife requires forests that contain, in adequate distribution, all sizes and ages of trees, areas of open and closed canopies, and a varied landscape shaped by natural disturbance. Conserving biological diversity also requires maintaining connections between diverse habitats, ecosystem functions (e.g., energy cycling, food webs, and fire regimes), and the integrity of aquatic ecosystems (Franklin 2005 pers. comm., Lindenmayer and Franklin 2002, Moyle 1996a, Rickman 2004 pers. comm., Smith 2001). Protecting the remnant stands of old-growth and late-seral forests and generally conserving older, larger trees are important components of maintaining forest diversity in the Modoc region.

Sierra Nevada and Cascades

Growth and Development

The Sierra Nevada underwent population growth of 130 percent between 1970 and 1990, compared to the state's average of 49 percent growth over the same period, and growth in the region is expected to continue at a pace exceeding the state average, adding about 195,000 new residents every decade (Duane 1998, SNEP 1996). The greatest growth and development have occurred in the mostly privately owned western foothills, particularly in the watersheds of the Yuba, American, and San Joaquin rivers, in the Lake Tahoe Basin, and around Lake Almanor. Development pressure is strong in the foothills adjacent to the metropolitan centers of Redding, Sacramento, Stockton, Merced, Fresno, and Bakersfield, particularly along the foothill river corridors near these cities. On the Sierra Nevada's east side, growth pressure is greatest between Reno and Susanville and near Bishop. Ranchette and residential communities are expanding from metropolitan areas of Reno and Redding along highways 395, 299, and 44 along the eastern foothills and across the northern Sierra and Cascades (Laudenslayer 2004 pers. comm., Rickman 2004 pers. comm.). New development along these highway corridors is displacing wildlife habitat and creating barriers in important wildlife migration areas. Growth has also increased the need to suppress fire, thereby expanding the conflict with efforts to restore more natural fire regimes in these fire-adapted ecosystems. Adding residents to the region will likely result in more citizen resistance to prescribed fire and more objections to the smoke it generates.

Forest Management

The SNEP project found that old-forest conditions (old-growth and late-seral forest) exist on 17 percent of national forest lands and on 47 percent of national park lands. On national forest lands

outside of wilderness areas, remaining old-growth forest is likely less than 8 percent (Franklin and Fites-Kaufman 1996, USFS 2001b). Old-forest conditions exist primarily as small patches. Large areas of old forest are uncommon in national forests, and only remnant areas of old-forest conditions exist on private lands. Fire-tolerant old forests, often with open canopies, have been replaced by dense evenaged forests that lack diverse wildlife habitat features and are prone to devastating wildfires. Maintaining diverse wildlife requires forests that contain, in adequate distribution, all sizes and ages of trees, areas of open and closed canopies, and a varied landscape shaped by natural disturbance. Conserving biological diversity also requires maintaining connections between diverse habitats, ecosystem functions (e.g., energy cycling, food webs, and fire regimes), and the integrity of aquatic ecosystems (Franklin 2005 pers. comm., Lindenmayer and Franklin 2002, Moyle 1996a, Rickman 2004 pers. comm., Smith 2001).

Altered Fire Regimes

Most of California's forest ecosystems have evolved with recurring fire, and each plant community of the Sierra and Cascades has evolved with some range of frequency of wildfire. The plant communities, topography, elevation, and climatic conditions influence the "fire regime," the frequency and intensity of fire for a specific plant community (McKelvey et al., 1996). In turn, the extent and intensity of fire influence ecological processes, shape plant communities, and affect wildlife. A continuum of fire regimes has evolved in the various forest types. For example, historically, ponderosa pine-dominated mixed conifer forests of the Sierra had a fire regime of frequent, low- to moderate- intensity fires. Before fire suppression, such a fire regime along with other conditions maintained a plant community of large, well-spaced trees. At higher elevations, lodgepole pine communities evolved with less-frequent but more-severe fires (McKelvey et al., 1996). Across the West, including in the Sierra Nevada and Modoc Plateau, aspen are in decline. Heavy livestock grazing, reduced fire frequency, historically high numbers of foraging deer in the 1950s and 1960s, the drying of meadows, and conifer encroachment have all contributed to the decline of aspen stands. Less-frequent fire over the past century has limited the regeneration of aspen trees. The results of prescribed fires in the Sierra have shown excellent ecological benefits (Keifer et al., 2000). Yet, while prescribed fire is considered a necessary tool to restore ecosystems and reduce the risk of catastrophic wildfire, and its use is increasing, it is currently applied to very few forested acres of the Sierra. Returning fire to the forests presents great challenges. The fire threat to people and expanding communities in the forests, excessive fuel loads created by fire suppression and past forest management practices, effects on air quality and conflicts with clean-air laws, and liability all impose difficult constraints on the increased use of prescribed fire and allowing natural fires to burn. Even with the best efforts to reduce fire conflicts and risks, in many areas, reintroducing fire will not be practical or politically possible, at least as a first treatment. Certainly in some locations, selective timber harvest may have to serve as the surrogate for natural fire to begin the process of restoring ecological diversity to forests. Mechanical thinning, however, will not provide all of fire's ecological benefits.

Livestock Grazing

The 1996 Sierra Nevada Ecosystem Project (SNEP) found that "over-grazing in mountain meadows is a threat to many rare species that are restricted to these habitats." Sierra and Cascades high mountain meadows and plant communities evolved without the kind of grazing pressure caused by livestock. Yet, as described by the Forest Service, "the riparian and meadow systems are the key livestock forage areas within allotments above 4,000-foot elevations. Studies have shown that 50 percent to 80 percent of the herbage used comes from these meadow

systems, which constitute a small percentage (generally less than 5 percent) of the allotment area. In the Sierra Nevada forests, the meadow systems cover an estimated 2 percent of the allotment areas" (USFS 2001b). The SNEP and the SNFPA also found that aquatic and riparian habitats are particularly affected by livestock grazing. The SNEP project concluded that "livestock grazing has been implicated in plant compositional and structural changes in foothill community types, meadows, and riparian systems, and grazing is the primary negative factor affecting the viability of native Sierran land bird populations" (SNEP 1996).

Invasive Plants

Invasive plants have transformed plant communities and contributed to the decline of native species in ecosystems of the Sierra and Cascades. Foothill oak woodlands and riparian plant communities have been particularly affected by invasions of exotic grasses and shrubs. High desert shrublands on the Sierra and Cascades' east side have also been altered by invasive grasses. Sub-alpine and alpine plant communities, however, are relatively intact, with few invasive plants (Schwartz et al., 1996). The understory of foothill woodlands of blue oak, interior live oak, valley oak, and gray pine are now dominated by wild oats, fescue, cheatgrass, and other invasive non-native grasses. Scotch broom and yellow starthistle have also degraded the Sierra Nevada and Cascades foothills (Bossard et al2000, DiTomaso and Gerlach 2000). Saltcedar, Russian olive, giant reed, eucalyptus, and English ivy are among the invasive plants that have intruded into low- and mid-elevation riparian habitats. On the east side of the Sierra and Cascades, the combined effects of invasive cheatgrass, which excludes native perennial and annual grasses, and livestock grazing have contributed to changes in fire regimes and transformed desert scrub and grassland communities

Climate Change

While climate change may influence all regions of the state, the consequences for vegetation, wildlife, and water resources will likely be most dramatic in the Sierra Nevada. Depending on the model and assumptions, scientists project the average annual temperature in California to rise between 4 and 10.5 degrees F above the current average temperature by the end of the century (Hayhoe et al2004, Schneider and Kuntz-Duriseti 2002, Turman 2002). Within 50 years, average wintertime temperatures are expected to rise between 2 and 2.5 degrees. A rise in this range would substantially reduce annual snowpack and increase fire frequency and intensity. By mid-century, the Sierra snow pack could be reduced by 25 percent to 40 percent and by as much as 70 percent at the end of the century (duVair 2003). Snow season would be shortened, starting later and melting sooner, while fire season would be longer and hotter. The reduction of snow pack and more extreme fire conditions would have cascading effects on water resources, plant communities, and wildlife. Oak woodlands may move higher, replacing pine and fir forest. At the lower elevations, the longer, warmer dry season could lead to increased fire frequency, likely converting some shrub communities to grasslands (du Vair 2003, Turman 2002). The expected changes in fire regimes will likely alter the abundance and distribution of plant communities, affecting habitats for wildlife (McKenzie et al2004, Miller and Urban 1999). So far, very little research has evaluated the consequences of projected climate change on species at risk in the Sierra and Cascades.

Aquatic and Riparian Habitats

The Sierra Nevada Ecosystem Project and the Sierra Framework highlighted aquatic and riparian ecosystems as vital to the sustenance of wildlife diversity. Aquatic and riparian ecosystems provide diverse and rich habitats for wildlife in the Sierra and Cascades (Moyle 1996a). There

are 67 aquatic habitat types in the region. Major riparian habitats include valley foothill riparian, montane riparian, wetland meadow, and aspen. SNEP concluded that aquatic and riparian systems are the most altered and impaired habitats of the Sierra. Of the 67 aquatic habitat types, nearly two-thirds are in decline. In the Sierra, of the 83 terrestrial species dependent on riparian habitat, 24 percent are at risk (Graber 1996)Six of the 40 native fish of the Sierra are listed as threatened or endangered. Only half of the 40 species have secure populations (Moyle et al. 1996). Among the fish species at risk in the region are several of California's native trout, including the Little Kern golden trout and Lahontan and Paiute cutthroat trout. Half of the 29 native amphibian populations of the region are at risk of extinction (Jennings 1996).

Central Valley and Bay Delta

Growth and Development

The main underlying cause of habitat loss and degradation, as well as other stressors, is the increasing human population and its high demand for a limited supply of land, water, and other natural resources. Up until the last few decades, much of the terrestrial habitat loss in the region has been due to agricultural land conversion. Recent land-use trends show a more mixed set of pressures from both urban and agricultural land conversion, depending on the habitat, topography, and proximity to major highways. Some habitats, such as wetlands and floodplains, are receiving increased environmental protection and thus less development pressure than other habitats (Landis and Reilly 2003). On the floor of the Central Valley, urbanization occurs mostly on previously cultivated lands, where much of the habitat has already been lost or highly degraded. The rate of population growth in the Central Valley is remarkable. Fifteen of the top 20 fastest growing counties in California between 1990 and 2003 were in the Central Valley, all exceeding the statewide average growth rate. This pattern is likely to remain the same during the next 50 years. Between 1990 and 2003, the Central Valley gained 1.8 million residents, nearly 30 percent of the total gain statewide.

Invasive Species Invasive plant and animal species are an important ecosystem stressor in this region, just as they are in other regions throughout the state (CALFED 2000, CalIPC 1999, CDFG 2005, Goals Project 1999, Hickey et al, 2003, Jurek 1994, Lewis et al, 1993, RHJV, 2004). In grasslands, some of the more challenging plant invaders include eucalyptus, fountain grass, gorse, medusahead, tree of heaven, and yellow starthistle. In riparian and wetland areas, invading plants include edible fig, giant reed or arundo, Himalayan blackberry, pampas grass, Russian olive, tamarisk (or saltcedar), pennyroyal, peppergrass and tree of heaven. Smooth cordgrass is a major concern in salt marshes. Oak woodlands are invaded by plants such as Scotch broom and French broom. Coastal habitats face alien species such as gorse, iceplant, and pampas grass